Some Strategies in the Acquisition of Phonology [1]

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1. Introduction

A model for the acquisition of phonology must account not only for the gross uniformities of the process from child to child and language to language, but also for the individual detailed variations we see in the case histories. The two elements of the model that perhaps throw most light on this problem of variation are maturation and strategies.

The importance of neuro-physiological maturation for the very earliest stages of the vocal behavior of the child is becoming obvious enough (e.g. Bever, 1961; Drachman, 1970b), though its details remain obscure. It is equally obvious, however, that as maturation begins to interact with the learning process, the notion of strategical choice must be brought into the account. In the present paper, I shall consider how the nature of representations, rules, and the functions of rules correlate with the use the child makes of (that is, the strategies by which the child employs) his articulatory abilities as they mature.

As a preliminary to my discussion of representations, let me briefly survey the question of infant perception.

2. The acoustic representation

The work of Stevens (1968), confirmed in part by that of Lindblom and Sundberg (1969), is very suggestive for a model of acquisition. This work shows, albeit by computer simulation, that vowel and consonant articulation positions do not constitute continua (as opposed to the view implicit, e.g., in Ladefoged 1967). Rather, there are optimal configurations at which comparatively large articulatory perturbations result in minimal changes in the acoustic output. The main optima apparently occur at the configurations corresponding to the primary cardinal vowels and the labial, dental, post-alveolar and velar positions of articulation; and cross-classification based on the characteristics of such articulatory-acoustical plateaus would seem to define the distinctive features.

It follows now that, for a viable communication system, this acoustic stability over a range of articulations should be matched by a perceptual stability (or invariance) over a range of sensations: perception should accentuate the plateaus, with consequent categorization of stimuli. But though the work of Liberman (1971) had already shown that such speculations from considerations of

the adult tract indeed apply to adult perception, this categorization could possibly--at least for the adult--be characterized as learned-in. Is there any real evidence, then, that the very young child can and does make categorical judgments concerning the language sounds he hears?

From the experiments of Bronshtein and Petrova (1952) in Russia it was already clear--using habituation-dishabituation techniques[2]--that a child less than one day old can distinguish musical tones, and the work of Kaplan (1970) at Stanford carried this over to sentence-final intonation contrasts in 4-8 month old children. More important, perhaps, is the evidence in Moffitt (1969) showing--by techniques similar to those in Bronshtein and Petrova--that a 5-6 month old child can discriminate between (synthesized) BAH vs. GAH. That in Eimas et al. (1971) in turn showed that the child makes categorical discriminations among stimuli synthesized to allow a single cue (voice onset time) along a continuum, for voicing in the consonants /p-b/--as early as one month.

These test results are of considerable importance, for they suggest that categorization in the speech mode of perception, at least for voice and place of articulation, is operative at a very early age; that is, that children in their first month have already paid sufficient attention to the language spoken around them to have discovered what Liberman called 'phoneme boundaries' for voiced vs. voiceless stops, at least in a word-initial position.[3]

Conversely, is there any important evidence that perception is somehow imperfect at an early age? First, leaving aside citations such as Jakobson's regarding confusion between nasalized and non-nasalized vowels in French (Ronjat, 1913), consider the experimental data. The work of Tikofsky and McInish (1968) suggests that 7-year olds on a forced discrimination test had highest error scores for the place of articulation feature /f-θ, v-ð/. Other research (Abbs and Minifie 1969) confirmed this for 3-5 year old children and showed also that, of the fricatives, these same pairs show minimal spectral difference.

Second, there is a sense in which, if Jakobson's (1968) implied comparison of auditory perception with color perception is valid, there ought to be a deficiency in infant auditory perception. It ought to be the case, for example, that earliest hearing distinguishes only between consonant and vowel; then among the vowels, and similarly among the consonants--just as the production system does. However, again consider the evidence, which I intentionally select at points that straddle Stevens' plateaus, viz., the labio-dentals vs. the interdentals. If this critical distinction is achieved, there is proof positive that perception is not a crucial problem, at least by the ages cited.

A. /f/ The Velten child has h^w initial, f final (15m):[4]
f everywhere by 22m.

/θ/ The Velten child has s initial, f final (22m):
s is final at 30m (Velten, 1943).

B. /f/ The Leopold child has w initial (23m), f final (?).
/θ/ The Leopold child has d/w (23, 25m), s/f (22m) (Leopold, 1947).

C. /f/ The Smith child has w initially, p finally (24m).
/θ/ The Smith child has g initially ('thank you'), t finally (24m). N.B. at 26m, 'thumb' appears as [wʌm]. "Hitherto he had always refused to say 'thumb', insisting it was a finger [wiŋgəl]." (Smith, 1970).

Noting that we make no argument from merger, only from distinction, the following points are relevant for these children.

1. The Velten child has no forms in θ until 22m, but then distinguishes θ - f.

2. The Leopold child has no forms in f for 22m, or for θ for 23m.

3. The Smith child has f-forms, but no θ-forms until 26m.

Note that the critical data, that concerning discrimination in minimal pairs, is quite absent in studies of acquisition, though earlier accounts (such as that of Preyer)[5] give partial lists of objects (body parts, household articles) which the child can identify by pointing, or commands the child can carry out.

However, it is reasonable to hold that children of the ages cited here indeed know words like (a) foot, finger, fix, feed, fall: knife, off, roof, laugh; (b) thumb, thing, three, throw, thank: tooth, bath, cloth, mouth, with.

If this is so, then the absence of such forms from the corpora suggests not accident but design--viz., avoidance, a strategy in this case connected with insecure representation.

However, this problem of insecure representations aside, and barring simple mistakes, there seems every reason to believe that the underlying acoustically based representation (hereafter, Representation I) corresponds substantially to the adult surface form by the time meaning has begun to play its fundamental role for the child, and that this representation is one in terms of segments composed of Distinctive Features.[6]

There is of course yet a further representation, in part derived from Representation I (the primary acoustic representation), in part reframed in accordance with a higher level analysis taking morphological and syntactical facts into consideration. This representation I do not discuss here for, to a considerable degree, it takes us out of the realm not only of acoustic and output representations but also of physiologically based processes (at least so far as the synchronic description is concerned), and involves us in what we must call the abstract representation and the learned rules of the language.[7]

However, the setting up of higher level abstractions is not the only way in which the primary representation may require modification. Consider that a possible strategy for setting up Representation I from the first raw acoustic data might be the following:

"Keep it as simple as you can."

The temporary use within Representation I for the Korean stops, of a feature "voice onset time" (VOT) might be an example of such a simple-minded strategy. But such a representation would require modification (perhaps to Tense vs. Lax [compare Kim, 1965])[8] even before production is attempted, in fact as soon as a number of cases occurred of understood utterances involving stop-final morphemes with vowel-initial following morphemes; here the intervocalic stop assigned "VOT degree 2" voices through, while that assigned "VOT degree 1" does not--against expectation. But notice that a simple "Modification of Representation I" strategy is likely to resemble the instruction.

"Do what you must--but only <u>where</u> you must,"

with the result that only stops in the critical position would require re-analysis. This suggests the possibility of multiple representations, or at least ambiguous representations, in the non-critical morpheme positions.[9] It is not clear that such ambiguities would ever be resolved.

3. <u>The production representation</u>

Basing himself on the primary, acoustical, representation (Representation I), the child must forge a physiological or output representation. Abstractly put, the articulation-perception conspiracy outlined above suggests a cognitive basis for the first production program, whereby all segments are re-categorized in terms of the most stable vowel and consonant. In a paper to the LSA (July 1970, see p.) I suggested a physiological analog to the systemic pressures resulting in what Jakobson called 'poverty of output'; and shall make one or two detailed references to such an analog in passing.

For the moment, let us take for granted exactly how much is produced, for I want to talk first about this second representation, and its improvement, in very general terms.

In producing an utterance, the child registers his attempt. This he does in two ways. He registers the configuration that he reaches, by tactile and proprioceptive feedback--let me call this Representation II. He also registers the external achievement, the sound he produces, by acoustic feedback--I shall call this Representation III.

We may now define the acquisition process in terms of the strategies by which the child systematically experiments with Representation II (his maturing production ability) in order to match his output (III) to the adult model (I).[10] As with initial performance, so with development, we might predict that the perception-production conspiracy will impose a quantum-jump condition--output may approach the model as and when some improved

physiological ability enables the output to be moved one quantum (or some integral number of quanta) towards the model.

I come now to the question: "What is a rule, that a child may know it?" From the first attempted production, there is a new parameter in the child's analysis: the relationship between his own (perceptual and production) representations. Put another way, the child has discovered rules. Could it be the case, now, that these rules define whole-segment substitutions? This is possible, but problematic,[11] for the quantum jump condition on changed representations would seem also to impose a quantum character on the rules relating representations.

So the child comes to have at least three representations, linked by sets of quantally defined rules. There is, too, some evidence that he will retain the two acoustical representations, as well as Representation II. The first (acoustic-input based) is required to account for the cases of such pathologies as laryngectomy or glossectomy (Drachman, 1969), besides the case of mutes (e.g., Lenneberg, 1962): for the former, a fresh Representation II is fairly easily devised, presumably on the basis of Representation I.

The third representation, in turn, will perhaps throw light on three problems:

1. The delayed 'updating' of the output for certain very frequent or affective forms--under the dominance of the 'local' acoustic image.

2. Certain cases of intermittent stuttering--where outputs like "ttt-come" suggest conflict between present Reprreentation II and older Representation III (cf. Stinchfield and Young, 1938).

3. Ability to adapt to local malformation of the tract--i.e., compensatory articulation, here interpretes as temporary change in Representation II, under dominance of Representation III.

With this background, I now propose to match some core concepts of a powerful cognitive model of acquisition, in particular that in Stampe (1969), with what might be their natural analogs in a maturation model. Notice that it is not at all necessary to suppose that the child's progress need be some linear function of his maturing ability to coordinate particular muscle systems. On the contrary, a crucial feature of my account will be precisely that the child devises strategies to diminish homonymy--the whole aim of his linguistic being, may I say!--at points when he cannot yet command the normal (language specific?) modes of articulation for particular segments or contexts.

I take first the notion of rule limitation--of which suppression is the extreme case--then that of rule ordering.

4. Rule systems, rule limitation, and maturation processes

In this section, I shall attempt to reinterpret some simple rule systems as formalizations of maturation processes giving increasing ability to a tract, but taking account of alternative strategies. In the simplest cases, to do this is sufficient merely

to invert the total set of rules and attach to each rule a number representing "months of age" for the child.

Thus, using the convention that the natural (i.e., maximal feeding) order of a pair of adjacent rules is the 'unmarked' order, (1) k to t, (2) t to p, are two simple unordered rules producing p for all k's and all t's. They correspond to the fact that two quantal developments will be needed before p-t-k are distinct (questions of contextual voicing apart), though these two stages need not take noticeably separate periods of time to traverse. The physiological representation (Representation II) correlating to this requirement in the maturation model (Drachman, 1971) is that (1) control of the tongue-intrinsic musculature matures later than that for tongue-extrinsic musculature; thus the first stop is extra-lingual, i.e. [p]; and (2) the tongue tip is the most mobile part of the tongue, and best supplied with feedback receptors; thus, the first lingual stop is [t], rather than [k]. The model only suggests that the overt development will be in this order: as I will later illustrate, individual children may jump stages, and occasionally reverse them.

A more complex example from a somewhat later stage of development is that of the treatment of lateral [l] in English, confining our attention for the sake of simplicity to word-initial position. A typical set of rules (cf. Edwards, 1970), 'unordered' in the sense already mentioned, is:

1. Loss of coronality, giving j^l (since initial l is [-vel, -Rnd]
2. Loss of laterality, giving j
3. Strengthening, giving y
   or glide loss, giving Ø.

From the point of view of the production representation (II), the problem here is to match a voiced non-nasal continuant; physiologically, it is to master the simultaneous use of a complex of tongue-intrinsic muscles to produce apical stoppedness and laterality.

First, it is obvious from the substitutions made that the place of articulation is correctly registered. Then for this case too, leaving aside for a moment the question of Glide Loss, inversion of the rule series corresponds to a fairly plausible maturation process, in describing which I shall mention various alternative strategies. At least the palatality of initial [l] is achieved if the tongue tip is turned down, contact with the roof of the mouth being denied to ensure laminar flow and thus preserve continuous voicing. At the first stage, the best that can be done is thus a glide [j]. The following stages concern the achievement of lateral release [j^l] and then apical contact [l].

Notice, however, that alternatives are available, by sacrificing one or other of the characteristics of [l]. Thus, if the last two stages are attempted in reverse order, apical contact will give a stop [d]: voicing may now be maintained, at least in pre-vocalic position, but continuousness is sacrificed. Alternatively, voicing and continuousness may be preserved easily be velic release, giving

[n]. A last alternative strategy I might mention would be the attempt to preserve continuousness with very close constriction--but note that this produces turbulent flow, with the penality of a greater air-flow requirement and special adjustment for voicing (cf. Klatt et al, 1968), a penalty which probably explains the rarity of the alternative [z].

Finally here, consideration of the gradual mastery of coordinating muscles adds to our understanding of the hierarchy of the environments in which [l] is at length to be correctly articulated. Palatograms of the kind made by Jones (1950) for English suggest that there is a graduation in the delicacy of control for the lateralization process. Control seems grossest for the low vowels and finest for the high vowels--the latter showing minimum lateral release. It is thus predictable that [l] will appear before low vowels sooner than before high vowels.

But even for such a simple case there remain some fairly impenetrable mysteries from the point of view of the "maturation plus strategies" model. One is the question of Glide Loss, producing forms such as [uki] for 'lookie'. It is difficult indeed to see how to account fur such a rule in terms of an 'attempt to pronounce l'. But note that this is the case only if that attempt is inevitably to be thought of as routed through [i] and [y], i.e., if the decision on Representation II is necessarily context-sensitive from the start. Consider again the strategy of setting up Representation II. The child is <u>forced</u> to choose a physiological representation (here, a tongue attitude somehow guaranteeing continuous voicing for the <u>l</u> segment). But suppose he in fact chosses to generalize the <u>velar</u> variant he hears. The (simultaneously chosen) strategy of withdrawal of the tongue tip now of course leaves the blade of the tongue in quite the wrong position to produce an 'accidental' [i] or [i̯], and the following [u] of 'lookie' absorbs the labiality which accompanies velarization. The result is 'zero'.

In such an interpretation, the later appearance of [i] and [i̯] in this word-position would suggest that the child has in fact changed his mind--again, he has made a strategic judgment; this time, that the palatal configuration will in fact reduce homonymy by producing an acoustically closer match to Representation I than he achieved before. I shall offer alternative suggestions for this case below (Sections 5, 6).

5. <u>Rule ordering</u>

It is not difficult to see, at least in principle, that some derivations the content of whose rules speaks to successive limitation or suppression of innate phonetic processes could be interpreted in terms of strategies for taking advantage of (quantal) maturations in articulatory abilities, where 'strategy' corresponds to the use of alternative derivations.

But there is one type of operation proposed by the cognitive model, namely rule ordering (that is, placing of rules in some

non-feeding relation), which it is much harder to find an analog for, at least in terms of the maturational part of the model I am considering. I shall first argue that certain putative examples of rule ordering are to be explained otherwise. I shall then perforce face the higher mysteries again.

5.1. The case of 'choo-choo'

At 19 months, Hildegard Leopold has forms like 'juice' = duš, etc., as well as a solitary form in č-, 'choo-choo' heard once as dudu. The two simple unordered rules, 1. č → j and 2. j → d cover the facts. At 20 months, however, she has 'juice' = du(i)š still, but now 'choo-choo' = cucu or juju, mainly the latter. Here we seem to have to do with the ordering of rules, the unmarked order (1, 2) producing the earlier forms, the marked order (2, 1) the later ones.

However, notice (1) We are dealing with a single form here (the form for 'church' was acquired later (at 22 months, only in a nursery rhyme), and already had [j-] in its first shape). (2) It is not clear from the account in Leopold that the early form [dudu] in fact corresponds to 'choo-choo' at all--rather than, say, to 'toot-toot'. (3) At 26-28 months, newly-acquired 'cheese' is [diš] and 'chubby' (name of a doll) is given as [dʌbi].

For this case we must thus reserve judgment, since it is unclear whether the examples in fact show us the child ordering rules in order to distinguish segments merged by the unordered rules. I shall discuss below (section 6) the importance of the paucity of examples.

5.2. 'Puddle' and 'puzzle', and other puzzles

A clearer suggestion that we may not constrain our model to handling simply articulatory ability is apparently offered in cases like that in Neil Smith (1970), where at 31 months 'puddle' gives [pʌ́gəl], while 'puzzle' gives [pʌ́dəl]; that is, the three ordered rules: (1) velarize final l; (2) coronal, non-cont → velar before velar l; and (3) coronal cont → stop, account for the data. It seems confirmed that "...the sequence [pʌ́də] was completely within the performing capabilities of the child, but he was incapable of applying it to the right adult form because of the pressure of his rules." (Smith, 1970).

Now rule 2 needs an explanation. Why, in fact, does velar harmony operate for stops but not for spirants?[12] Perhaps it is because, while a spirant by its nature is released, the homorganic stop is in fact not separately released before [l]. But note too that, even granted that the difference in treatment of underlying spirants vs. stops in thses cases can be thus explained, we must still apply the rules 2 and 3 in the order given, rather than in reverse, unmarked order; otherwise a merger will occur, and 'puzzle' will also appear as [pʌ́gəl].

Similar cases can be adduced from the Leopold data, for voiced and voiceless stops. Thus,

1. while final t appears at 22 months, final d is always lost up to 24 months.

2. while initial k sometimes appears as k (rather than d) from 18 months, initial g always appears as d up to 24 months.

Underlying voiceless stops, it seems, are produced correctly for voicing and place before the corresponding voiced stops are. Whatever the physiological explanation for this, the word "underlying" in the above statement is crucial, i.e., the processes apparently do note take place in the tract, but are to be considered essentially mentalistic in nature.

5.3. Ordering and homology of articulation

The third (and most important) case I want to discuss is from Velten. Assuming that at 15 months 'lamb' = bap and 'up' = əp, then the two rules (1) m → b, and (2) b → p are seen to be unordered, i.e., in feeding order. However, at 22 months, we see that 'broom' = bub, and 'train' is dud, while 'bed' is but, from which it might be deduced that rules (1) and (2) had been ordered, that is, placed in a bleeding relation.

I want to deal first with the problem of voicing in final stops and nasals.[13] I shall then re-appraise the relevance of this example to the problem of rule ordering.

Notice that for Velten's child nasals are first produced word-finally when preceded by the vowel [a]. This is simply explained in terms of the sluggishness of velum control at the early stages. Since the velum must raise for an obstruent whose closure is further forward in the tract, but may be open for a vowel (the degree of opening being inversely proportional to the height of the vowel), it is clear that the optimal condition for velum lowering in a final nasal obtains when it is preceded solely by a low vowel, by another nasal followed by a low vowel, or by h followed by a low vowel.

At 22 months, we see the optimal condition fulfilled, as in 'arm' = am, as well as in forms in ha- such as 'ham' = ham. The assimilations for θ and l in 'thumb' = nam and in 'lion' = nan likewise fulfil this precondition.

With this background, we may look again at the crucial forms; in short, while 'bed' = but, 'jam' = dab and 'home' = hub. I now suggest that final [b] from [m] no longer merges with true [b] for the simple reason that the 'nasal' [b] is at this stage precisely that, viz., a stop whose voicing is aided by velar leakage. Meantime the pharyngeal widening which accompanies voiced stops in adult language (cf. Rothenberg, 1968) is presumably yet lacking--so that final voiced stops are still unvoiced.

At 24 months, Joan Velten masters whatever mechanisms are required for voicing in final stops, while nasals continue to be fully nasal only in the protected conditions mentioned. The last stage, probably involving full mastery of the velum, comes at 30-33

months, when final and then medial nasals are at length correctly pronounced in unprotected environments too, e.g., where preceded by a stop or spirant as in 'apron' = u.pin, 'farmer' = fa.ma.

At first sight, the moral of this story, though important, seems negative. We might assert that, since it is a case of non-homologous outputs (that is, outputs that merely sound alike[14] though quite differently produced), this case is simply not relevant to the problem of child rule ordering.

But I wish, on the contrary, to suggest that non-homologous production is in fact one of the mechanisms by which the need for rule ordering may actually be circumvented. At a point where massive homonymy obtains through the merger of m, b, and p, a temporary strategy has been discovered, making use of the developing mastery of the velum, to distinguish at least underlying m from b-p--though the hierarchical nature of the control dictates that this can only be successful in certain specifiable environments, viz., the protected ones in the above account. As soon as both the stop-voicing mechanism and the velum are finally mastered, however, all three segments are automatically disambiguated.

Numerous cases are cited in the literature (e.g. the examples from Smith, above) where, despite the fact that mastery of the pronunciation of a given segment has not been achieved, yet an apparently identical segment appears in the function of a substitute for some other. I now suggest that most if not all of these will prove to be cases of strategic non-homologous articulation[15]--cases, that is, not of rule ordering, but in fact of the circumvention of rule-ordering.

Confirmation for the position I have taken on homology is partly provided in a study of the production of initial consonant clusters in children from 18-34 months by Menyuk and Klatt (1968). For an intended production of 'Brian', the time from the release of the stop to the steady state for the [a] vowel is longer than in 'bike'. The authors point out that "an adult listener will not hear an [r] when presented with the word intended to be 'Brian', but...it is likely to believe that some kind of phonetic segment is interposed between the [b] and [ai]. This segment is acoustically most similar to a [w]."[16] It is thus most important to elucidate the facts of child articulation in such cases, with the aid not only of spectrography (compare Kornfeld, 1971) but also with continuous palatography, EMG and X-ray cinematography.

From scattered remarks in the literature (e.g., Preyer, 1914: 107, and Jesperson, 1922:104), it seems likely that the problem of homology will prove the more acute as it is examined for younger and younger children.

Comparing the case of Hildegard Leopold, we see now the expected variation between individual strategies. Like Velten, Leopold produces true nasals before producing voiced stops in final position. Unlike Velten however, Leopold 'acquires' not only final nasals in protected and unprotected forms alike, but even nasal + stop clusters, before acquiring final voiced stops. The similarly expected differences in overall time of development

of course apply too. Thus, while final nasals begin to appear for Velten as early as 16 months, for Leopold no final nasals appear until 26 months--the first, incidentally, being the velar nasal.

Notice that a common strategy, at least for English speaking children en route to the distinction between final voiced and voiceless stops and spirants, is to halve the homonymy by lengthening the vowel before the underlying voiced members of these pairs. It is easy to predict that the apparently non-distinctive feature of length will usually be attempted before the apparently distinctive one of voice; whatever the command system for voicing finally turns out to require (cord adjustment, larynx lowering, pharynx laxing, or some complex of these), it is clearly simpler to continue an already given command (that for voicing, plus the configuration for a vowel) than to switch commands. It is equally obvious of course from the gross over-length of vowels recorded (cf. Naeser, 1970), that we have here to do with rule-guided behavior, rather than mere imitation of vowel length.[17]

6. The strategy of avoidance

In my discussion of perception I referred to the possibility that, at least so far as the labiodental and interdental fricatives are concerned, the absence of illustrative forms from the corpora is more than an accident, and suggested that it is in fact connected with insecure representation at the primary (acoustic) level. I now consider other evidence and implications from silence.

In discussing the development of voiced stops and nasals in final position in the Velten data, I noted that at the time (22m) when nasals sounded like voiced stops, underlying voiced stops were unvoiced. For the earlier stage, I now want to point out, the only form supporting the rules implied here is the form for 'lamb'--and in fact no example of a word containing an underlying final voiced stop appears before the crucial 22nd month. Since there must be many words ending in voiced stops known to the child, it is tempting to suppose that such words are in fact being avoided by the child--in this case, I surmise, avoided until a strategy can be devised to distinguish nasals from voiced stops, i.e., to undo some of the massive homonymy obtaining.

The parallel strategy in Leopold refers to initial consonants, in particular, to palatal stops. Consider the following common forms probably known to a small child: (a) chocolate, chair, Chuck (name), cheese: lunch, touch, scratch, catch; (b) juice, Johnny, jam, jelly, jump, June: huge, cage, bridge, change. The absence of forms, e.g., in initial [č] for the whole of the first 24 months suggests the strategy of avoidance again--avoidance of honomymy with the product of [ǰ] in initial position.[18]

Let me revert now to the problem of initial [l]. In the light of the above argument, it is perhaps not wholly foolhardy to suggest that the 'zero' exponent of an underlying initial [l] may prove an example of a strategy which I shall call 'local avoidance':[19] and if that is a possible case, then surely so too

may the (so-called) deletion of initial spirants be one--as an alternative strategy to total avoidance of the words containing them.[20]

Now there are important implications from such avoidance (apart from the implication for methodology).[21] First, much avoidance may be interpreted as total suppression of forms for which certain kinds of rule-ordering are to be performed--though it remains to clarify how to distinguish these from cases where homonymy is tolerated in the output.

But this of course implies that the rule ordering will proceed before the corresponding forms are produced--that is, proceed purely mentally.

It is also reasonable to claim now that, since we shall in any case not witness certain stages of development (the cases of rule ordering for which forms showing the unmarked order are totally suppressed), there may well be further stages of all derivations for which no overt evidence will appear in the corpora--the quantum changes again occurring mentally.[22] This removes an important kind of constraint on the rules we may write to correspond to the proper derivations of forms: in particular, such considerations seem to support the claim that the rules ought to recapitulate the strongest form of the 'quantal change' hypothesis we began with. That is, every derivation must in principle be fully quantal, regardless of the absence of illustrative forms in the corpora.[23]

7. Conclusions

To sum up, this paper offers various kinds of data that explicate or modify the cognitive model for the acquisition of phonology suggested by Stampe. I cited evidence to suggest that segmentation and featural analysis are tools available to the very young child, and that there is reason to suppose that at least his acoustical representation substantially matches the surface adult shapes. In offering an account of the acquisition of multiple representations, I claimed that the notion 'phonological rule' could be simply reconstructed as a relationship between certain such representations.

I also examined the possibility of reconstructing the notion 'derivation', by re-interpreting rule derivations and the limitation and suppression of rules, in terms of hierarchies of alternative strategies for the use of maturing coordinations of muscle-systems.

Finally, I discussed two strategies by which the child may begin to resolve the massive homonymy in his output without resorting to rule-ordering in the early acquisition period. Some ordering problems are circumvented by the simple device of avoiding words containing one of the merging segments; others, by the adoption of a non-homologous articulation for at least one of the merging segments--so that in both cases later maturation (corresponding to simple limitation and suppression of innate rules) will undo the rest of the homonymy.

Footnotes

1. This paper will appear in the Proceedings of the Urbana Conference on Phonology, held in April 1971.

2. Techniques of this kind could perhaps be used to test for memory of the content of unstressed syllables during the early acquisition period. Does the child, in fact, attend only to the stressed syllables?

3. Better (pace Ladefoged, 1959:416) as syllable onsets in initial position.

4. f initially only when supported by f-final, in 'faf' (the name of a dog) "after assiduous practice," so za 'that' (12m) does not even partially contrast with initial f.

5. Preyer's child was still confusing 'Ofen' with 'oben' (he would look up, asked to indicate the oven) at 20m. It is interesting that the interpretation with -b- dominated: it suggests that the "stable articulation point" concept might account for some perceptual and production substitutions.

6. A view entirely in accord with that of Stampe (1969). For doubts, cf. that in Kornfeld (1971). The cases are by now legion where forms not heard or produced by the child for some time are later produced in a form fully updated according to the later system.

7. Consider how much later the relevant data for reconstructing such rules as tri-syllabic laxing, velar softening, spirantization, or vowel-shift is 'available' to the child. Many pairs such as critical-criticize, etc., are required before the child is forced to reanalysis.

8. Stevens and Klatt (1971) suggest that the presence or absence of a well-defined F1 transition following the onset of voicing is an even more primitive cue than VOT, for the infant with little previous exposure to speech. In this case, the Korean child would have (a series of) three strategies at his disposal in perceptual analysis.

9. This seems an entirely verifiable hypothesis. The environments not under rule-government should show greater individual production variation--from instance to instance of the same utterance--for the same person, or from person to person.

10. By definition, then, the child is very early aware of his deviant pronunciation--and must be so, if he is to improve it (Cf. Gutzmann (1894), but also the opposing view in Delacroix (1924)).

11. The attractiveness of such a hypothesis is simply that it suggests a reconstruction of the notion 'derivation' in terms of the acquisition process. Derivations, in this interpretation, would arise during acquisition, with the (quantum-wise) approach of the production representation to that of the model--as also indirectly suggested in Section 4.

12. Spirants do not appear in the Smith corpus for 26m. The delayed mastery of the delicate articulatory control of spirants is predicted by the maturation model (Drachman, 1971).

13. I choose the position giving greatest homonymy in output. It is clearly predictable that initial nasals will present no production problems--even if the velum tends to be raised as part of the speech-ready configuration, an initial nasal command will inhibit the raising very easily.

14. Cf. Jespersen (1922).

15. In regard to the zero exponent of initial [l], which bothered me earlier--here too, it might well prove that what is acoustically zero is in fact represented by some weak articulation, by definition non-homologous with zero.

16. The production-perception conspiracy of course emphasizes this: any stimulus identified as a segment will be assigned to the 'nearest' segment.

17. For an account of the intimate way in which vowel length is related to voicing of following (final) consonants, see Drachman (1970b).

18. Confirmed from the shapes of the two putative examples, both showing 'support' for initial č later in the word. A topic probably worth investigating in this regard is that of avoidance of one or other of a synonymous pair: better yet, choice of words, for children in bilingual environments (cf. Leopold Vol. II, paragraph 497).

19. In partial mitigation of the ad hoc appearance of such a strategy, consider the following interesting case from Sanskrit of a consipracy concerning -l (Zwicky (correspondence to Lakoff, Dec. 1968)). (1) No root ending in [l] belongs to an athematic verb class...(a class for which the initial dentals of many conjugational endings would then immediately follow l-), (2) No root shows a sequence such as l + dental, and (3) If a derivational process brings together a root-final -l and a suffix-initial dental, the union-vowel [i] is inserted.

20. I do not at this point want to suggest that cases of loss of <u>final</u> consonants have anything to do with 'avoidance': I can only suppose, for the latter, that a constraint on syllable structure is operative.

21. The implication for methodology is important too. Before we can clarify the hierarchies by which homonymy is tolerated in attempted outputs, systematic recordings must be made not only of outputs but also of comprehended forms, so that we may sharpen the notion 'avoidance strategy.'

22. But again, it is not clear how much <u>overt</u>--though sometimes secret--practice may be involved (cf. Weir, 1962). According to the present model, some children suppress nearly all forms until they have, as it were, ordered the rules correctly--these are 'late' speakers whose very first productions show comparative maturity of phonological structure.

23. Which of course flatly contradicts the hypothesis of footnote 10 regarding the interpretation of the first production representation as containing <u>wholistic</u> rather than quantally defined) substitutions.

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